deviation will grow over the distance travelled by the laser relative to the wafer.

In industry this may be anticipated by providing a so called scribing lane, which is a region in between each of the rows and columns of semiconductor elements formed on the wafer, wherein the score may be formed. A variation in the cutting direction will not directly result in the loss of semiconductor elements if the scribing lane is chosen to be broad enough. However, the dimensions of the scribing lane (broadness) determines to some extend the number semiconductor elements that can be formed on the surface of the wafer. As will be appreciated, the scribing lanes must therefore be as small as possible. It will therefore be understood that a lot of effort is put in accurate rotation of the wafer, such that the variations in rotation angle are as small as possible. This slows down the separation process.

Another disadvantage is that the pattern of focal points and the orientation of the secondary laser beams relative to the wafer surface is determined by the characteristics of the diffraction grating. It is therefore not possible to amend this pattern during the process without interrupting the process and replacing the diffraction grating.

Summary of the invention

It is an object of the present invention to provide a method for separating semiconductor elements, which alleviates the abovementioned problems, which enables accurately forming scores in either direction and which enables amending the pattern of focal points of secondary laser beams during the process.

This is achieved by the present invention by providing a method according to claim 1.

By altering the first grating structure to a second grating structure for use in the second direction, it is no longer required to use the same diffraction grating structure for both the first and the

second direction. Therefore, a suitable direction grating structure may be used for the first direction and another suitable grating structure may be used for the second direction; each of the first and second grating structures adapted to the requirements of the direction wherein they are used. The second grating structure may, for instance, simply be a rotated mathematical image of the first grating structure, or may alternatively be a completely different grating structure. This enables moving the wafer (or the laser) in a different direction (e.g. sideways instead of back and forth), without having to rotate the wafer relative to the laser first and without having to replace the diffraction grating. Variations in the rotation angle and/or cutting direction caused by rotation of any element relative to any other element in the process are thereby anticipated. The scores to be formed in the wafer dicing method may therefore be placed more accurate, and the required scribing lanes can be made smaller than in conventional wafer dicing methods. As a result, the density of semiconductor elements on the wafer surface may be increased, which reduces the costs of production.

The method may be applied to method for separating

perpendicular to the lines of the first grating structure in the plane which is perpendicular to the primary laser beam.

It will be appreciated that another possibility for altering the first grating structure to the second grating structure comprises rotating said first diffraction grating relative to an axis of rotation parallel to said primary laser beam. Said rotation should be performed accurately over the desired angle of rotation.

According to a second aspect the present invention provides a device for separating semiconductor elements formed on a substrate, in accordance with claim 8.

In the third aspect of the present invention there is provided a diffraction grating in accordance with claim 12.

The present invention will now further be elucidated by a description and drawings referring to preferred embodiments thereof, directed to a method and arrangement for separating a semiconductor element formed on the surface of a wafer, wherein the semiconductor elements are distributed over the wafer in a matrix distribution, such

CLAIMS

(100)

1. Method of separating semiconductor elements on a substrate, such as semiconductor elements formed in a wafer of semiconductor material, using a laser producing at least one primary laser beam, wherein said at least one primary laser beam is split into a plurality of secondary laser beams using a first diffraction grating having at least a first grating structure and by impinging said at least one primary laser beam on said first grating structure, and wherein at least one first score is formed by moving said laser relative to said substrate in a first direction, said method further comprising a step of forming at least one second score by moving said laser relative to said substrate in a second direction, characterised in that, said second grating structure is comprised by said first diffraction grating, and before said step of moving said laser relative to said substrate in said second direction, said method comprises a step of altering said first grating structure to a second grating structure, by moving said first diffraction grating such that said at least one primary laser beam impinges on said second grating structure.

2. Method according to claim 1, wherein said step of moving said first grating structure comprises translating said first diffraction grating.

3. Method according to any of the previous claims, wherein said first and second grating structures are chosen such that said second grating structure is a mathematical image of said first grating structure by rotating said first grating structure over a rotation angle.

4. Method according to claim 3, as dependent on claim 1, wherein said step of altering said first grating structure comprises rotating said first diffraction grating for forming said second grating structure.

5. Method according to claim 4, wherein said step of rotating

said first diffraction grating comprises rotating relative to an axis of rotation transverse to said at least one primary laser beam.

6. Method according to any of the previous claims, wherein said second direction is transverse to said first direction.

7. Device for separating semiconductor elements formed on a substrate, such as semiconductor elements formed in a wafer of semiconductor material, comprising a laser arranged for producing at least one primary laser beam, a first diffraction grating having at least a first grating structure, said first diffraction grating arranged for splitting said at least one primary laser beam into a plurality secondary laser beams by impinging said at least one primary laser beam onto said first grating structure, means arranged for moving said substrate relative to said laser in at least a first direction for forming a first score, said means arranged for moving being further arranged for moving said substrate relative to said laser a second direction for forming a second score, characterised in that, said second grating structure is comprised by said first diffraction grating, and said device further comprises means arranged for altering said first grating structure to a second grating structure, by moving said first diffraction grating such that said at least one primary laser beam impinges on said second grating structure.

8. Device according to claim 7, wherein said means arranged for altering said first grating structure are arranged for translating said diffraction grating relative to said at least one primary laser beam.

9. Device according to any of the claims 7 or 8, wherein said second grating structure is a mathematical image of said first grating structure by rotating said first grating structure over an angle of rotation.

10. Device according to claim 9, wherein said means arranged for moving said first grating structure are arranged for rotating said

first diffraction grating around an axis of rotation transverse to said at least one primary laser beam.

11. Diffraction grating for use in a method according to any of the claims 1-6, said diffraction grating comprising a first part having a first grating structure and a second part having a second grating structure.

12. Diffraction grating according to claim 11, wherein said second grating structure is a mathematical image of said first grating structure by rotating said first grating structure over an angle of rotation.

13. Diffraction grating according to claim 12, wherein said rotation angle is a straight angle.